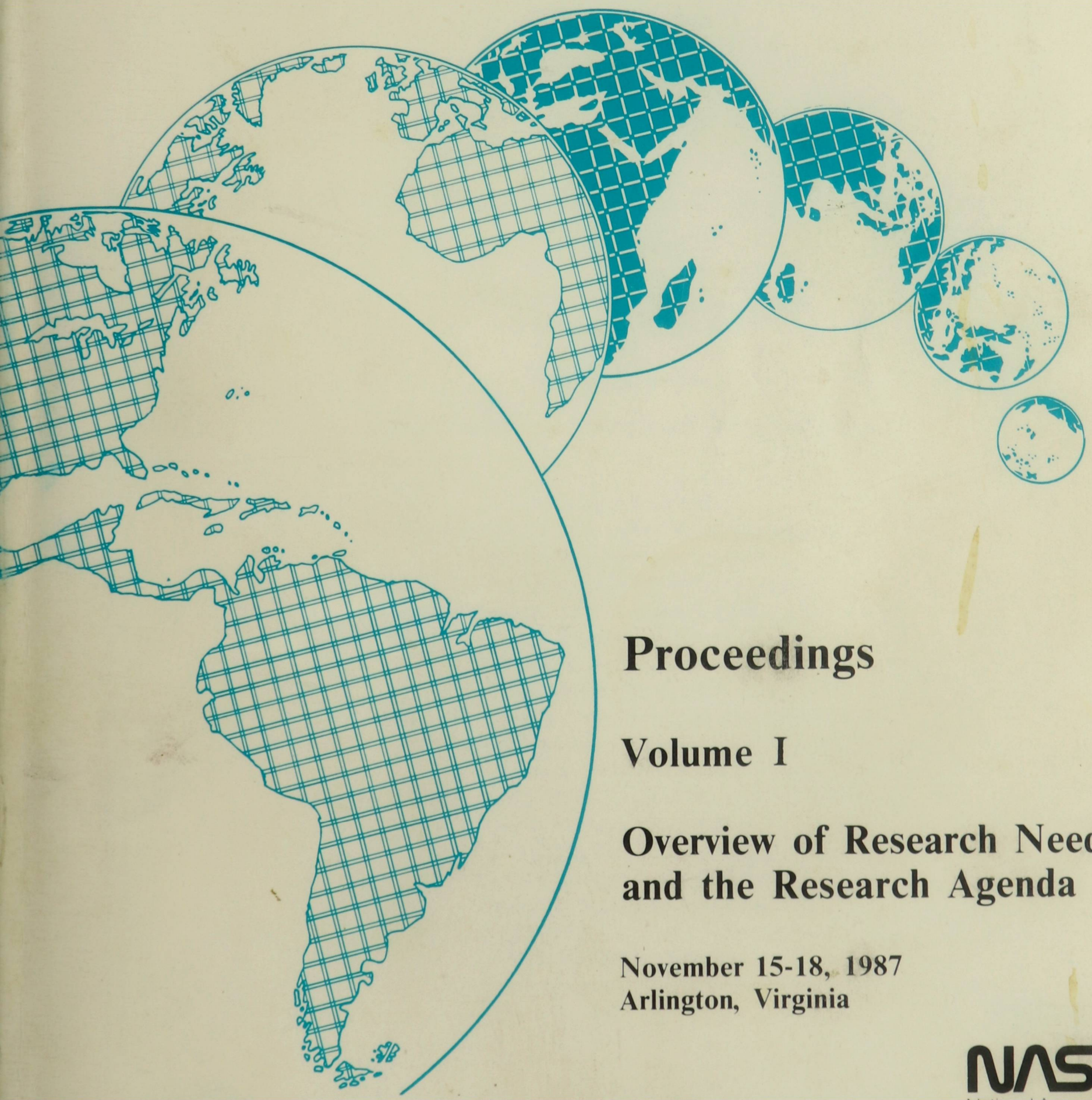
International Geographic Information Systems (IGIS) Symposium: The Research Agenda



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Volume I

Overview of Research Needs and the Research Agenda

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INTERNATIONAL GEOGRAPHIC INFORMATION SYSTEMS (IGIS) SYMPOSIUM

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INSTITUTIONAL RESEARCH NEEDS TO MAXIMIZE GEOGRAPHIC INFORMATION DEVELOPMENT

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ABSTRACT

Recent research and commentaries suggest that institutional factors influence information technology adoption to a greater degree than technological capabilities. Accordingly, our national research agenda regarding geographic information should focus on the goal of Multipurpose Land Information Systems, and the process of interorganizational coordination needed to meet this goal in addition to Geographic Information Systems and other tools and technologies. Some suggested research areas include topics in functional applicability; information, capital and human resources; sector development, including federal, state and local governments, academia, private sector and professional associations; definition of organizational roles and responsibilities; policies, directives, and authority; social issues; and the development of our national resources and appropriate metadata.

1. INTRODUCTION

A broad focus on "geographic information" (GI) is suggested as the environment for appropriate research and a conceptual basis and framework from which to disaggregate, integrate, access, and display information. Well over half of all public information can be references by location, including natural resources; infrastructure; land use and cover; demography; land tenure; and geographic, legal, and geodetic references. It is developed and used by virtually all public agencies and many diverse private sector interests, thus providing a linking mechanism between these entities. Technologies and tools such as Geographic Information Systems (GIS), remote sensing, and satellite surveying are improving the accuracy, management, and usefulness of GI. A broad focus can maximize GI technologies, but also general information technologies such as data base management systems; telecommunications, distributed systems, office systems, artificial intelligence, real-time systems and others.

Multipurpose Land Information Systems (MPLIS) are the most commonly viewed goal or objective of efforts in this field. Regardless of available technologies, this goal is generally considered as a way to maximize increasing information resources and investments with widespread benefits for all.

Some general trends and conditions influence the development of MPLIS. Governments are increasingly faced with multidimensional and multijurisdictional issues and decisions, often with reduced time frames and financial resources, and greater impacts and complexity. Public decision makers often do not have information available or in the proper format for their needs. They are also experiencing greater expectations for services, efficiency, accountability and fiscal responsibility. Improved effectiveness of information resources can assist in addressing these needs and public management in general.

Government has a unique role as primary creator, disseminator, user, analyzer and regulator of information. It also has a social responsibility to both protect information and provide it to the public. There is unprecedented growth in the development and use of information technology, but research reveals a 10 to 15 years gap between its development and widespread adoption.[1] When implemented, it often results in increasing fragmentation and incompatibility of information for multifunctional purposes. At the same time, single purpose legal directives and reporting requirements increase while recordation methods often grow out-of-date. Despite declining computer costs, information costs have been increasing at all levels.

These trends and conditions point to an increasing need for multipurpose and interorganizational information resources. The increasing volume of GI, entitles generating and using it, and applicable technologies suggest that this is particularly true regarding GI. Thus it is suggested that a key process to achieve the goal of MPLIS and GIS implementation is interorganizational coordination. Accordingly, the research agenda must also focus on this process and the following issues in addition to technological development to achieve this common goal.

2. CURRENT INSTITUTIONAL RESEARCH

Even when considering the fast pace at which information technology is becoming commonplace in our lives and organizations, there is limited empirical research about the factors influencing its adoption in governments. There has been virtually no research conducted about the factors affecting GI technology adoption. While some general research has been conducted at all levels of government, the largest body of research about computing in public organizations has been conducted during the last 15 years by the Public Policy Research Organization (PPRO) at the University of California, Irvine, with a focus on local governments.[2] Their findings generally apply to other levels of government as well. With this symposium being held to help define the research agenda for an upcoming National Science Foundation (NSF) award for a National Center for Geographic Information and Analysis, it is additionally appropriate that these findings are considered as much of this research was also funded by NSF.

In a recently proposed theoretical framework for analyzing the factors affecting the adoption of information technology, Kraemer and King at PPRO describe "technological infrastructure" and "organizational context" as the two main categories of influences affecting these adoptions.[3] The most rapid rate of development or change is in technological capabilities, thereby creating organizational opportunities, but they suggest that organizational context is the dominant force affecting change. They conclude that, "regardless of the significance of new technological developments, ... (they) will not be incorporated into organizations unless prevailing organizational commitments permit and encourage their adoption."[4]

Recent commentaries by professionals in the GI field also suggest that more in-depth institutionally focused research is needed. Dueker concluded that the "technology ... has increased significantly, but institutional innovation has lagged", and "MPLIS objectives make a purely technological fix insufficient."[5] Chrisman asserts that GIS should be designed to meet social goals such as equity and that "technical concerns must remain secondary."[6] In addition, it is increasingly observed that technological capabilities are and can not be fully utilized without institutional reform and attention to broad social and political issues.[7 8] Further, in comparing this country with others, our less developed organizational attention to this field, and decentralized and somewhat fragmented form of government, may restrict our ability to maximize technological capabilities to help improve public sector effectiveness and compete globally.

The broad nature of GI and wide variety of factors influencing technological adoption and its usefulness

for multipurposed needs, makes a research agenda difficult to define and accomplish. The following suggestions are important factors, and potential research areas for successful implementation of MPLIS and GI technologies.

3. TECHNOLOGIES

Technological capabilities are increasing at an unprecedented rate while costs are decreasing significantly. Hard and software independence and merging capabilities are also increasing and provide additional incentives for organizational adoption. Many technological improvements are occurring in areas related to GI, specifically GIS, remote sensing, image processing, satellite surveying, and others, but also in general information technologies. The volume of information, numerous sources and networking technologies facilitate distributed rather than centralized systems. Full utilization of GIS and MPLIS requires consideration and maximization of general information technologies including telecommunications, reprographics, artificial intelligence and others. Focus and research is needed to utilize today's general information technological capabilities to, with GI technologies, improve the generation, accuracy, completeness, timeliness, storage, retrieval and manipulation of GI.

4. FUNCTIONAL APPLICABILITY

To be useful, technologies must be applied to existing needs and problems. GI technologies can be applied in four general areas or combinations thereof. Firstly, natural and cultural resources, usage and regulation are important application areas where GI technologies, such as GIS and remote sensing, have been applied. Secondly, application in physical resources or infrastructure, such as transportation networks and utilities, are increasing as maintenance of these capital intensive systems receive growing attention. Technologies such as computer aided drafting, protogrammetry, and satellite surveying have been traditionally applied in this area. A third area is socio-economic information or human resources such as health, employment, housing and voting habits of people. A fourth area is institutional and financial applications such as land use, zoning, and tenure; including property rights, valuation, regulation and ownership; public lands management; expenditure distribution; revenue generation; fiscal impact analyses; and risk evaluation and management. Traditionally, GI technologies have not been widely used in these areas, but new opportunities are being recognized and utilized.

Each of these areas has numerous single purpose applications within it, but a useful trend is consideration of related needs when developing applications. Another trend is to build integrated systems to utilize information from more than one of these GI categories. Some applications are evaluating environmental impacts on public health, public safety (police and fire), emergency preparedness and management, optimizing site considerations for economic development, and broad organization wide needs. Technologies applicable for each of these four application areas and their integration for multifunctional needs should receive research and development attention.

5. RESOURCES

Four types of resources are essential for the development and implementation of MPLIS and GI technologies. Each requires examination in a research context.

5.1 Information

Information, rather than solely technology, must be considered and developed as a key resource like personnel and capital in the emerging "information society". In general, applicable information resources are traditionally considered as digital cartographic data as input for GIS. More recent capabilities to access and display automated tabular data as attribute records, image processing and satellite positioning have expanded this scope. In addition, most GI still remains in a manual form, such as manual records, photography and maps, and thus should and are also being considered as GI resources. Systems should be designed to geographically reference these manual forms as well as other automated systems. Therefore, research attention should help design multipurpose geographic reference frameworks. Geodetic, cartographic and legal referencing are all needed. At the local level, and for state and federal land owners, the parcel is the lowest common denominator to disaggregate GI resources to facilitate accurate and maximum usage for multiple purposes. Smaller scales or larger units, such as census tracts, zip codes, and political boundaries, might be appropriate and cost effective for data handling and access for other purposes. Reference and design of GI resources should be based on individual and collective needs, when possible, as can be recommended by appropriate research.

Commonality of data can be achieved through guidelines, standards, uniform data definitions, data dictionaries, and increasing hard and software independence. National digital cartographic standards are in the process of being finalized. These standards are essential to ensure compatibility at the federal level and will hopefully lay a foundation to build compatibility for more detailed state and local data. Research attention to this area would be helpful to many local entities and help ensure the compatibility of their data for state and national uses. Finally, to be most useful, data must be secure, accurate, accessible, maintained, integratable and timely. The research agenda should include identification of mechanisms to ensure these needs are met.

5.2 Capitalization

GI development is traditionally constrained by the public or "free" nature of governmental information. An economic incentive does not generally exist in the public sector to invest in or maximize information resources, and especially not for multipurpose needs. An exception is when it has single purpose applicability and funding based on user fees, such as in utilities, which accounts in part for the emerging growth of GI development in the infrastructure area described above.

Financial analyses have been limited, and are needed to document the costs associated with GI development and use in general. In addition, costs with and without MPLIS and GIS, identification of opportunity costs and model cost/benefit analysis methodologies are needed. Applications research in financial areas would also be useful to help justify investments on economic grounds. Capitalization and financing mechanisms such as general appropriations, cash funding through user fees, development of information as a funded utility, partnerships, and privatization should be analyzed and evaluated for potential impacts on information design, development and use.

5.3 Human Development

Awareness, vision, a sense of "community" and spatial consciousness are critical factors to build a much needed critical mass to increase the rate of integrated GI development and implementation of MPLIS and GIS. This author clearly remembers the time and factors leading to this personal understanding, but relevant factors differ for people based on their unique perspective. Our country's population is characterized by strong individualism and a "frontier spirit" which has contributed to our fragmented development of a GI reference base and lack of a custodian. Cooperative efforts and information networks are frequently considered appropriate with this condition, but research attention and development is needed to include and encourage participation by different people and disciplines involved in GI.

Leadership and "project champions" are frequently considered as primary needs for the successful adoption of innovation. Cases are sometimes cited where other factors might be lacking, but implementation is successful due to a particular individual. Evaluation of personal understanding, managerial competency, and drive as a public servant, are needed to help build these strengths in others. In addition to identifying these personal qualities, it is important to select appropriate positions and actors within organizations as essential allies and partners to implement MPLIS and GIS. Research to evaluate and determine appropriate partnerships, personal networks, teams and scopes of effort would be helpful.

Multidisciplinary education is a growing and critical need for successful human development in this field. Some argue that a new discipline is needed. "Knowledge engineers" are emerging. Research is needed in appropriate curricula development to educate both regular and continuing education students about how technologies can be applied to functional areas in addition to technologically based education. It appears the availability of technically competent professionals might not meet future demands. Research is needed to project employment needs and capabilities to encourage curricula development and students to meet these demands. Students should also be educated in public policy and administration, planning, finance, intergovernmental relations, records management and land recordation to become successful implementors, users and managers.

Human development efforts and educational programs should vary by targeted group. For example, elected officials are solely responsible to the electorate and often have short terms of office. Thus it is sometimes difficult to convince them to invest in projects that might not achieve results until after their term is over. Accordingly, short term visible accomplishments should often be included in the project design to ensure political justification. Managers desire information to promote greater productivity and decision making capabilities, while users need more programmatic information. Attention to these differing needs, but also incentives for working together should be incorporated in implementation research. Technological development in user interfaces and artificial intelligence is increasingly important to maximize human potential in this field.

5.4 Systems and Facilities

A wide array of systems and facilities generally make up an organization's technological infrastructure. Some identification, suggestions and prioritizations of appropriate capital investments, particularly in systems linkages through communications networks, and data input and output devices would be a useful focus for research efforts.

6. SECTOR DEVELOPMENT

Resources, inventories, development and analyses are needed in all relevant sectors to maximize the capabilities and integration of MPLIS and GIS to use information and resources from many organizations.

6.1 Federal Government

For decades, both the executive and legislative branches have been addressing GI from various perspectives.[9] Rising costs and expenditures, with increasing threats of redundancy and incompatibility, have received more recent attention in the 1980s. In 1982 the General Accounting Office concluded that $45 million was spent on computer mapping between 1970 and 1981 and identified areas of duplication. The Congressional Research Service published a study in 1987 concerning the incompatibility of data generated by various state and federal agencies in the Yellowstone ecosystem. It recommended that a GIS framework be considered to manage these various data sets and such a project is underway. The Office of Technology Assessment is conducting a study of federal information dissemination to state and local governments and will consider the GI perspective in part of this analysis.

Federal agencies were directed by the Office of Management and Budget (OMB) in 1983 to coordinate digital cartographic activities, resulting in the Federal Interagency Coordinating Committee on Digital Cartography (FICCDC). Improved coordination, some analyses and proposed exchange standards have resulted. A Federal Geodetic Control Committee (FGCC) exists with many of the same agencies, to help establish a densified geodetic network in coordination with state and local governments. Numerous activities and pilot projects are underway, but inventories and analyses of these efforts are limited. Last year, OMB proposed that GIS be one of 17 major systems to be analyzed by their office. FICCDC and its counterpart in the Department of Interior (IDCC) have begun reviews and inventories, but further inventories of digital and other data from various sectors, and accessible in a GIS format would be an excellent resource and goal. The U.S. Geological Survey and Bureau of the Census entered into a historic agreement to build the first digital database of the country to support the 1990 Census, but much more can be done to maximize its value for other purposes. A research agenda could help develop an overall view of federal activities and needs to develop recommendations for national policies, executive action and legislative initiatives.

6.2 State Governments

States are emerging as a key sector in this field for many reasons. This is due to federal financial difficulties and delegation of responsibilities, growing state activism and self-governance to help improve their economic climates. States create legal and operating environments for local governments. They also can reference and access federal information and build linkages with local governments. However, to date, states have received less research attention and analysis regarding information technology than the federal and local governments. An initial inventory and analysis of state GI activities has been conducted by this author, and a network of state representatives is emerging, but these efforts identify the need for further research.[10] It is suggested that a research concentration on this sector could result in needed statutory models to assist both state and local governments. This focus also would provide useful comparisons of experiences and serve as building blocks and "laboratories" for much needed federal GI policy development. States are competing with each other in economic development efforts, but this is causing improvements in all. Regional partnerships are also emerging and a focus on GI development can assist these trends and other statewide issues.

6.3 Local Governments

Municipalities, counties and special districts are developing GIS and MPLIS, but like all levels of government, at a much slower rate than the growth of technological capabilities. Many advocate that MPLIS initiatives should begin at this sector or at "grassroots" levels, and the vendor community generally sees the existence of almost 80,000 units of local government as a fertile area for market development. This sector has a long and complex development time line to be organizationally able to build multipurpose and interorganizational resources and systems. It also has generally greater information, capital and human resources needs than the federal and state governments.

Counties traditionally manage the greatest amount of land information at the parcel level, but usually in departments or administrations managed by elected officials. With responsibility to the electorate, rather than a chief executive or administrative officer, they often do not have incentives or direction to modernize their systems or work with other departments or governments. Municipalities provide most services to the public such as utilities and public safety, and direct and regulate land development, but they rely on counties to manage land information bases for many needs. In addition, special districts provide services such as utilities, schools, fire and others, and exist for specific geographic areas. Regional associations of governments and non-profit utility notification centers are emerging to also develop and manage GI.

Many excellent projects are being developed throughout the country and many local government professional associations are beginning to review and present programs on various aspects of this field. However, inventories, understanding and evaluation of this sector's activities, needs and opportunities would assist these entities, help develop linkages with state and federal agencies, and incubate areas for private sector development and value added information.

Noteworthy interorganizational approaches are emerging, such as in the partnership of the City and County of San Diego; with various local governments and utilities as in Indianapolis; and public/ private partnerships as in Ada county, Idaho. Comparative case studies analyses, evaluations, and potential models should be developed in addition to general reviews of the huge local government sector.

6.4 Academic Community

Like in the other sectors, initiatives are flourishing, but the country's strongest institutions are currently competing with each other for NSF's GI and Analysis Center. As in the states, this competition has many positive aspects. It is hoped that after final decisions are made, other academic institutions can conduct research to complement the Center as additional research areas are identified by the proposals and this symposium. NSF is receiving GIS related proposals in response to other solicitations and it is hoped some conceptual and useful linkages can be made between them and the Center. To maximize available funding, perhaps research in functional applications and GI technologies can be supported by these other solicitations, allowing the Center to concentrate on more broad based, institutional research. In any case, like the other sectors, inventories and publicity about academic activities and programs would be extremely helpful in the educational process to build needed human resources.

6.5 Private Sector

Though GI technology adoption has not occurred at predicted rates, marketing efforts are expanding and new companies are emerging to stimulate such growth. The private sector should address current research findings which suggest that institutional reforms are needed to avoid fragmented and duplicating efforts by conducting and supporting relevant research. Larger companies have traditionally sponsored research in information technology adoption and should do so in the GI area as well. Avenues for companies to work together, such as private industry councils, are needed and should be stimulated by governmental or academic initiatives. Companies can generate capital and potentially create nonprofit corporations to meet some of the needed research agenda. They could help sponsor and conduct inventories and educational programs, analyze and compare case studies, and evaluate privatization options within criteria established by the public sector. They also should document the GI industry and establish business networks to maximize strengths and partnerships while reducing costs, and helping the public sector through public/ private partnerships. These efforts will also help identify and develop markets for further corporate growth.

6.6 Professional Associations

Today there are numerous associations concerned with GI issues, including public managers such as the International City Management Association (ICMA); functional users such as in public works, law enforcement, assessors and planners; and data developers such as the American Association of Geographers (AAG) and the American Congress on Surveying and Mapping (ACSM). Broad based groups supporting all of these areas for one level of government, such as the National Association of Counties (NACo) are also addressing GI issues. The educational and integrating roles of the associations will grow as well their numbers both in membership and interested organizations. Some organizations, such as the Urban and Regional Information Systems Association (URISA) and the Institute for Land Information (ILI) are serving as umbrella organizations and are working together to define and capitalize on their unique strengths to help address a broad spectrum of needs. Progress is occurring, but could be aided by a research focus to help identify roles. Currently it seems at least one GI related conference or session is being held each week by one of more of these groups and association involvement is escalating. Concentrated focus on appropriate roles, functional applications, level of expertise, memberships, audience and specific messages would help everyone select relevant groups and conferences to meet individual needs and maximize their time and budgets.

7. DEFINITIONS OF ORGANIZATIONAL ROLES AND RESPONSIBILITIES

Existing general government trends and the above sector review reveal the growing overlap of interests and development in GI. At the same time, functional redundancy, differing reference bases and financial consciousness are increasing, and the need to work together to maximize resources and develop MPLIS continues to escalate. Departments, agencies, governments, academic institutions and numerous private entities compete, but must also find common ground and work together to accomplish common goals. In particular, information resources must be designed with other purposes in mind to develop MPLIS. The cost effectiveness of multiorganizational approaches is being evidenced, such as in a 1987 Study by the Joint Nordic Project. They concluded that single agency projects result in benefit-cost ratios of 1:1, multi-agency projects with 2:1 and multiorganizational approaches with 4:1.[11] Further evidence of these benefits, and case examples of intergovernmental and public/ private/ academic partnerships should be documented and evaluated, including possible models to serve as useful examples.

Definition of appropriate roles and responsibilities of various sectors is needed for the development, maintenance, and networking of various data sets. Understanding of information needed for specific

purposes, whether it be policy development and strategic planning, operational management, or the location of a utility line, will help determine these roles and responsibilities as well as mechanisms to fund them. Frequently GI is developed for a single purpose. This is often the case today, such as in infrastructure or utility management. Even if without funding, other potential users can participate in GI resource designs. If these future users are not able to subsidize development, developers can often be convinced to maintain compatible data sets. These and other implementation strategies, as well as definitions of appropriate roles and responsibilities, should be an integral part of the national research agenda.

8. POLICIES, DIRECTIVES, AND AUTHORITY

General information policies are emerging in the public sector as the general focus moves from information technology to also include information resources. Coordination groups are emerging to address this broad focus. For example, the State of Minnesota has three advisory groups: an Information Policy Council consisting of policy advisors and deputy directors of agencies; a Systems Advisory Council with agency data processing directors composing its membership; and an Intergovernmental Information Systems Advisory Council. Their legislature recently created an Information Policy Office to also help coordinate activities between agencies and governments. These and similar initiatives are resulting in the adoption of policies assuring that information is an organization-wide, rather than solely an agency or departmental resource. By doing so, data compatibility and maximum usefulness for top decision makers can be assured, but it is an evolutionary rather than revolutionary process.

Recently we are experiencing an integration of general information policy and GI policy. This is healthy, but difficult, as GI policy requires development of information as an organization-wide resource, but also as an interorganizational resource to be most valuable. An increasingly important element in the current research focus on the adoption of information technology is the influence of external factors. This is also appropriate for GI research, but must additionally analyze the application of external influences and the process of interorganizational cooperation needed to meet the MPLIS goal.

Development of appropriate executive and legislative directives to apply policies and implement and maximize MPLIS and GI technologies are also an appropriate research focus. As noted, OMB directed federal agencies to coordinate digital activities, and some Governors and Legislatures have taken similar action to coordinate some or all aspects of GI. To date, only a few states are known to be directed to coordinate GI in an integrated manner, but many states and local governments are struggling with similar issues. Identification, analysis and evaluation of these and related directives, as well as development of models, such as legislation, are appropriate for the GI research agenda. Directives and authorities for the development of MPLIS are virtually non-existent. Of all important factors in GI development, technology is improving most rapidly, while the appropriate legal framework is probably developing most slowly. In addition to executive and legislative directives, administrative regulations and judicial review are important elements of this framework. Existing directives have often reinforced the disaggregated nature, responsibilities and development of GI in this country. Many organizational and technical risks exist in development of MPLIS, but they are compounded by lack of authority and legal questions. Potential liabilities for inaccuracy, misrepresentation and unauthorized disclosure are just a few areas of concern, often without precedence. The research agenda must include identification, analysis, and evaluation of relevant legal frameworks, and develop models to direct and maintain MPLIS and GI development.

9. SOCIAL ISSUES

Many of the above issues are related to the wide array of social issues related to information development. Information must be designed and managed to abide by requirements for access, disclosure and confidentially. A variety of directives exist and are being revised to address this increasingly complex area, especially in regard to Gi where data exchange occurs frequently. MPLIS should be designed to ensure equity, but such an objective is increasingly difficult as emerging public/ private partnerships might confuse the design of resources for strictly public good. The research focus should address the needs of the public, including both individuals and the common good, as well as social issues, as primary aspects of MPLIS and GI resource development.

10. NATIONAL RESOURCE DEVELOPMENT

This country has traditionally had more information about itself and technology adoption than any other, but we can not maximize its usefulness without appropriate organizational focus, modernization, and coordination. While governments are in competition for increasingly scarce resources, their roles are becoming less distinct and their functions and information resources are overlapping. The public is increasingly frustrated by growing levels of bureaucracy and tax burden. We are constantly reminded of technological developments, and other incentives and demands for cooperation, reduced redundancy and improved effectiveness, but a focus and support system to facilitate improvements is essential. An investment in our shared future can be made by developing and marketing our information resources to maintain our strength as the world's knowledge and technology center. Proactive development of GI creates a focus, opportunity, and process for working together. It also can help maximize our resources, technological capabilities and other investments; improve public management and effectiveness; incubate business development; create and expand markets; and strengthen our international competitiveness. Analyses and comparisons of approaches in other countries, many with more developed MPLIS and GI policies, would also be a useful component of our national research agenda. A research challenge is to develop our GI resources, applications, technological capability, and institutional framework from a strategic perspective to improve our competitiveness while effectively participating in the global community.

11. METADATA

To effectively steer the future and support MPLIS and GI resource development, we must understand where we are, what we have, where we have been, what works and does not, and why. Needs for MPLIS and interorganizational coordination have existed through time, but technology has only recently emerged to encourage and support these initiatives. A historical review and analysis from both perspectives would be a very useful addition to the research agenda.

A common vocabulary and definitions are sorely needed. Baseline information about initiatives, technological capabilities, resources, applications, pilot projects, directives and other activities is needed for all sectors. This "metadata" development will help identify our current status, locate and reduce redundancy, encourage commonality and sharing, and establish resources for future work. It also will improve understanding of successful approaches, and identify potential pitfalls, barriers, needs, partnerships, funding mechanisms, opportunities and cooperative approaches. Case studies should also be conducted to avoid repetition of failed approaches and identify successful models for replication. Additional research needs and opportunities will also emerge through this process.

12. CONCLUSIONS

Available research about the adoption of information technology in public organizations and commentaries by professionals in the GI field are reaching similar conclusions. They suggest that increasing attention is needed regarding institutional issues as the primary factors influencing technology adoption. It is suggested that instead of considering GIS as the goal and primary research focus, GI should be considered as the research environment and GIS and other technological capabilities evaluated as tools. Therefore, MPLIS should be considered as the goal and interorganizational coordination as the non-technical process to achieve this goal. From this frame, a variety of suggested institutional research areas are proposed to complement and maximize the value of technological research.

The suggestions outlined in this paper are made with the realization that all of the wide array of research needs suggested here and elsewhere can not be funded by NSF or accomplished by the new GI and Analysis Center. These institutional research needs are suggested to identify additional areas requiring analysis and development in addition to technological research to meet our broad, long term goal of MPLIS and GI resource development. Initially, a broad national focus and research frame is needed. Once conceptualized, the realistic role and expected accomplishments of the Center can be determined. Ideas and direction can then also be provided, and financial support gathered, for research work to be conducted by other academic institutions as well as the public, private and other sectors. It is hoped the institutional research ideas presented here can also help serve as background and focus for needed strategic national policies regarding geographic information resources and technologies development and application.

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